

ROADMAP

Rethinking of antimicrobial decision-systems in the management of animal production

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Report on critical points of action (including levers, incentives and real time indicators) to be used at farm, industry, society and regulatory levels for reducing AMU

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About the ROADMAP research project

The overall aim of ROADMAP is to **foster transitions towards prudent use of antimicrobials (AMs) in animal production in different contexts to manage antimicrobial resistance (AMR). Prudent antimicrobial use (AMU) will be achieved by enhancing antimicrobial decision-systems along the food and drug supply chains.** ROADMAP will focus on supporting animal health and welfare through prevention and health promotion actions.

AMR is recognized as a significant threat to global public health and food security. Overuse and improper use of AMs in many parts of the world contribute to the emergence and spread of AMR. Although human and animal health require AMs, it has been estimated that two thirds of the future AMU growth worldwide will be in animal production. Improving the management of AMU in farm animals is therefore a critical component of dealing with AMR and optimizing production in the livestock sector. Nevertheless, the variety of contexts of AMU in the livestock sector is a major challenge to managing AMR. **There is no “one-size-fits-all” solution to improve AMU and strategies must be contextually developed** (for instance, strategies used in the Danish pig industry are difficult to adapt and adopt in the French free-range poultry farming). Successful solutions must be combined and tailored to the production systems and the social and economic context in which they operate.

ROADMAP will meet three general objectives, in line with the EU AMR Action plan: i) **Rethink AM decision-systems and animal health management;** ii) **Develop options for encouraging prudent AMU in animal production;** iii) **Engage all actors in the food and drug supply chains in fostering a more prudent use of AMs.**

Project consortium

Part. N°	Participant organisation name (acronym)	Country
1	Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE) **	France
2	Association de coordination technique agricole (ACTA) ***	France
3	Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) **	France
4	University of Liverpool (ULIV) *	United Kingdom
5	Cardiff University (CU) *	United Kingdom
6	James Hutton Institute (HUT) **	United Kingdom
7	Alma Mater Studiorum - Università di Bologna (UNIBO) *	Italy
8	Aarhus Universitet (AU) *	Denmark
9	Eigen Vermogen van het Instituut voor Landbouw en Visserijonderzoek (EV-ILVO) **	Belgium
10	Research Institute of Organic Agriculture (FiBL) **	Switzerland
11	Stichting Wageningen Research (WR) *	Netherlands
12	Swedish University of Agricultural Sciences (SLU) *	Sweden
13	Southern Agriculture and Horticulture Organization (ZLTO) ***	Netherlands
14	European Forum of Farm Animal Breeders (EFFAB) ****	Netherlands
15	Fundacion Empresa Universidad Gallega (FEUGA) ****	Spain
16	Dierengezondheidszorg Vlaanderen (DGZ) ***	Belgium
17	INRAE Transfert (IT) ****	France

* Universities/veterinary schools

** Research institutes specialized in both fundamental and applied agricultural and veterinary sciences

*** Public and private advisory services Organisations

**** Knowledge transfer and Innovation organisations

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List of acronyms and abbreviations

Antimicrobials	AM
Antimicrobial reduction	AMR
Antimicrobial usage	AMU
Community of Practice	CoP
Community-based participatory research	CBPR
Decision support system	DSS
Living Lab	LL
Real time indicators	RTI

1 Summary

We understand of ‘critical points of action’ as: ***Physical, technical, psychological, social, and institutional motivations, incentives, stimulators, levers or structures which leads to action that has the potential to initiate or drive substantial and lasting change, including actions directed towards overcoming barriers and lock-ins which hindered action.*** We link it to the mathematical ‘critical point’ on a graph, as well as the idea of ‘critical mass’, and the sociological understanding, where it is being used to describe a group of people who are able to make lasting real change in an environment.

We have primarily focused on critical points of action at the three levels: 1) regulatory / governance level, 2) industry (agriculture or food chain related industries), and 3) farm and agricultural local actor level. In addition to these three levels, we open up for viewing it at a fourth level, namely the societal level, which became increasingly debated among ROADMAP partners.

Methodologically, we have built the report on 12 interviews with LL-coordinators during Jan.-Feb. 2021, to understand the many perspectives and contexts of complex situations. Living Labs exist and are under development in 11 sites with different focus areas and within different sectors throughout Europe. Due to the Covid-19 pandemic, all LLs were delayed, because it was impossible to meet physically. Seven of these LLs have had one or two meetings. We use the current experience and consideration to understand important steps regarding identifying and initiating critical points of action, seen as a Participatory Action Research approach, and in relation to social learning, communities of practice (CoP) and systems thinking, providing interesting ideas on leverage points and places to intervene in a system.

We realized that a LL can operate at different levels, either in parallel, to address a cross-cutting issue related to AMR and fostering transitions towards prudent AMU, or in consecutive steps. This means that innovations and implementations can be of the following types:

- a) Technical – e.g. promoting health or preventing / handling disease in a certain sector),
- b) Social at more levels from farm to society and in organisations.
- c) Institutional and structural level: who pushes the development and use of antibiotics?
- d) Any of the above in combinations, and initiatives targeting or involving societal levels broadly.

The following questions are paramount to address during the establishment and first evaluation of the mode and space of operation in ROADMAP-LLs:

- a) Is there a ‘good match’ between the problem addressed, the level at which it is addressed, the critical points of action, and the combination and range of stakeholders?
- b) How to transform ‘conflicts of interest’ to ‘commonality of interest’ within the Living Lab?
- c) Does the Living Lab have the necessary ‘space of operations’?

Living Labs can be viewed as formed across different CoPs, potentially with the potential to form new CoPs in new organisational structures, recognised ‘Communities of Action’, if the enabling environment is present, and the above mentioned ‘good match’. In this case, they may foster change through a transition from conflict of interest to commonality of interest. Furthermore, the potential to identify context relevant places to intervene in a system, provides an interesting framework which can be unfolded much more when the body of experience builds up within and between the different LL contexts.

2 Introduction: clarifying critical points of action

In contrast to much previous research which has been limited to a focus mainly at farm and farmer levels, and behaviors, attitudes and perceptions at these levels, ROADMAP aims to go beyond these levels and take a wider multi-stakeholder approach and include more levels. This means that the outlook of ROADMAP goes further than the psychological aspects and individual drivers of AMU. ROADMAP looks at the farm environment, the interactions between farmers, veterinarians and other key actors in the agricultural sector and the food systems. Social, cultural, institutional and economic aspects tend to be set aside in much research, and ROADMAP sets this at the center of the research, and draw on new concepts and apply them to the issue of AMU in animal production.

To fully enable ourselves to identify critical points of action, we needed to develop a common understanding of ‘critical points of change’ and build on this. We took an approach to first understand the term, and then bring it into the context of the animal agricultural sector, and relate it to participatory action research and specifically Living Labs as a platform from where change processes potentially could be fostered, initiated and/or driven.

Seen from a mathematical point of view, “critical points” are the points on the graph where the function's rate of change is altered. This can be a change from increasing to decreasing, or the opposite, or it can be in concavity, or in some unpredictable fashion. It is important to understand that it is not the extrema – that means that “critical points” are different from “turning points”. The fact that it is not extrema is interesting and could be linked to the second understanding of “critical points”, which we linked to ideas of criticality and “critical mass”.

The term “critical” refers to critic, critical and criticality, which arises from terms like “decisive”, “threatening”, or “dangerous”. If we remain in a natural scientific framework, the concept of critical mass could be interesting. This term was first used in relation to nuclear physics, where it refers to the smallest mass that can sustain a nuclear reaction at a constant level, that means: the minimum amount of a fissile material required to create a self-sustaining fission reaction, whereby something is happening and keeps happening. It has also been used as part of business terminology, e.g. in relation to company establishment and growth, where the critical mass is the point at which a company becomes self-sustaining and no longer is reliant on further investments from its investors to stay economically self-sufficient. This means – in a company context – that the company has repaid the investors their loans and now runs as a business, but not yet exist safely above its critical mass.

However, what may make it interesting for us in this context is that in sociology, it is being used as a group of people who are able to make lasting real change in an environment, in terms of driving a change of perceptions and practices. In this ROADMAP project, we built on critical points of change in the first instance (MS18 and MS19), which we understood as physical, technical, psychological, social, institutional and organizational instruments, actions, interactions, structures and other factors which can change AMU at different levels, by stimulating actors and stakeholders, overcoming barriers or loosening lock-ins. In our work we include three levels: 1) regulatory / governance level, 2) industry (food and agriculture related

industries), and 3) farm and agriculture local level, and we understand actors as closely related to stakeholders, and use these two terms intertwiningly.

We saw critical points of actions as closely related to critical points of change. In the original framing in the ROADMAP project description, it was called ‘critical points for action’, but grammatically, there's a difference between 'critical points of action' and 'critical points for action'. 'Critical points for action' suggests a specific point in time, rather than the content of the actions taken. In this context, we work with the concept of critical points of action, because the important focus is the action that is taken.

Based on the above consideration, we therefore came to an understanding of ‘critical points of action’ as:

physical, technical, psychological, social, and institutional motivations, incentives, stimulators, levers or structures which leads to action that has the potential to initiate or drive substantial and lasting change, including actions directed towards overcoming barriers and lock-ins which hindered action.

We have primarily focused on critical points of action at the three levels: 1) regulatory / governance level, 2) industry (agriculture or food chain related industries), and 3) farm and agricultural local actor level. In addition to these three levels, we open up for viewing it at a fourth level, namely the societal level, which became increasingly debated among ROADMAP partners. These points of action become embedded in systems which also include knowledge and management as well as practice systems which allow new knowledge and points of action to become absorbed (that is, having absorptive capacity), and transformed into lasting practices and change.

3 Methodology and theoretical frameworks

3.1 The research approach and data collection to this report

This reports aims at understanding and identifying critical points of action to address identified problems and challenges in animal agriculture in relation to the use of antimicrobials (AMU standing for ‘antimicrobial use’), and to relate this understanding to relevant theoretical frameworks of participatory action research (PAR) and, more broadly, participatory approaches, systems thinking, as well as actionable knowledge. Furthermore, it researches the potentials of Living Labs (LLs) as a place of fostering this. Living Labs exist and are under development in 11 sites with different focus areas and within different sectors throughout Europe. The insights from these 11 LL + 1 additional LL, which is currently at hold and in a re-thinking process, have been collected through individual interviews with all 12 LL-coordinating teams during January and early February 2021. Due to the Covid-19 pandemic, some LLs are under development, whereas others have experience in going through the first steps of their process. This report sets out to use the experiences and considerations of the first Living Labs to build on, and to analyse the potential of Living Labs as drivers of identifying and initiating change.

3.2 Participatory approaches and Participatory Action Research (PAR) in relation to reduce AMU in animal agriculture

We reviewed previously (in D3.1 and D3.2) how the concept of ‘participation’ had been used in different ways and contexts, and with a particular focus on ‘participatory research approaches’. This is particularly important when a project like ROADMAP builds on ‘participatory methods and approaches’. When investigating critical points of action, we build it on an assumption that action is possible at multiple levels, and that it will require participation and taking ownership by several actors and stakeholders. No matter at which level, action will be planned, there is an emphasized need to ensure that the ownership over any development is shared and mutually agreed among the participants.

Participatory approaches to AMU reduction in animal agriculture were particularly investigated with respect to farmer groups. When investigating critical points of action, we go beyond this. In ROADMAP, the research processes may in the best-case scenario enable social learning between the participants in the project, including in the case studies and the Living Labs. However, the balance between involvement, responsibility, power and control over the processes need to be agreed on, as a multi-stakeholder approach is taken, and it is not enough to focus solely on ‘behavioural change’ – even though it is critically questioned whose behaviour should be changed. Not only should the focus be broadened from individual, farm level and farmer group level change, to transitions at the levels of governance, institutions and frameworks around animal agriculture, but awareness should also be taken as to reaching out to wider communities and society, because the project aims as fostering change towards ‘prudent use of antimicrobials’. In D3.1, we came up with five conclusions on participatory research approaches. They will not be fully outlined in the following, but key points from these conclusions are linked to initial ideas of critical points of action in the following:

1. A participatory research project building on multi-stakeholder involvement will need to develop multiple versions of ‘optimal mix of stakeholders’, fitting to the diverse contexts within the project, and work with critical points of action at different levels. We see this unfolding in the eleven different Living Labs in ROADMAP, where farmers, farm-related actors and much of the veterinary, agricultural and food industry are core to the changes, alongside authorities and governance systems with which the actors in the Living Labs engage in some cases. The stakeholders need to be involved throughout the project and its different phases, including planning, implementation and conclusions, and analysing and interpreting the results.
2. One major potential of PAR is to create structures, which can transfer conflicts of interests among stakeholders to commonality of interests. Structures which keep the fundamental problem going, can be big obstacles to change when the existence of some stakeholders depend upon these structures. One example is price systems, which encourage collecting large amount of animals in small spaces, hence high AMU. When joining forces and building co-created solutions toward this as a common problem(s), based on mutual understanding and a common analysis of the

problems and potential solutions, can enable identification of critical points of action leading to lasting change of problematic situations.

3. It is important to recognize that the responsibility for planning and conducting the project and interpreting results as well as taking ownership of the process and disseminating the results does not belong to the research teams alone, but to all involved. This means that the changes and transition go beyond individual or group of individuals, and beyond the groups involved in a given project, like ROADMAP, because it deals with structural and institutional change, and will consequently also affect systems and sectors.

Capacity, empowerment and ownership over the processes are important outcomes of participatory research projects, which like ROADMAP set out to foster lasting change. However, different levels of action require different approaches, which involve actors and stakeholder to different degree. When analyzing the critical points of action in each context, this should be included in the considerations and analysis.

3.3 Theoretical frameworks of systems thinking and knowledge systems

The following subsections will briefly outline theoretical frameworks of potential relevance and importance to understand and analyse critical points of action to reduce AMU in animal agriculture, and to stimulate change and transition processes towards lasting systems changes. Although reviews could be relevant for each subsection, we base our current exploration on selected angles and sources, which we found particularly interesting in the context of animal agriculture with the overall goal in mind of fostering prudent use of antimicrobials. We will use these frameworks to discuss the cases from the ROADMAP Living Labs and Case Studies.

3.3.1 Systems thinking and leverage points to intervene in a system

There are many interesting and valid theories on systems in general, drawing on widely different types of systems, e.g. ecosystem, social systems, farming systems, food systems, organisational systems and any combination of these. In this context of ROADMAP and investigating critical points of action, we focused on Donella Meadows' ideas on systems, in combination with her twelve points of places to intervene in a system, because it seems relevant to the aim of ROADMAP and in accordance with the overall aim of Living Labs. In brief, Meadows (2008, edited by Wright) characterised systems by being more than the sum of its parts, being structured in different ways with multiple interconnections, which often operate through the flow of information. Many relationships in systems are non-linear. In ROADMAP, we work with animal farming sectors as systems, which are part of larger food systems, as well as interwoven with professional systems, industry systems and others. A system has stocks, flows and works dynamically to establish an equilibrium, using different buffers. There will always be various feedback loops in a system which help equilibrating and creating stability (which can be understood in different ways). Information is delivered in the feedback loops, which can affect future behaviour. In relation to ROADMAP, this also points to possibilities to identify critical points of action and intervene to change the systems dynamics. Systems are complex and not

simple, and the ‘behaviour’ of the systems can also be complex and involve different oscillations and can often be determined by looking at the strength and the length of feedback loops. If a balancing feedback loop is changed, e.g. delayed, the dynamic in the system may be altered. Resilience is in the core of this, and there will always be limits to resilience. Although some systems have the property for self-organisations, some system needs maybe management for productivity or stability, and certainly also for resilience. It is important to be aware on the dynamics of changing systems – since this is what ROADMAP is interested in – and consider what growth and changes may mean to a system. No system can grow indefinitely in a finite environment. It is furthermore important to be aware that non-renewable resources are stock-limited, whereas renewable resources are flow-limited. The problem area of AMR can relevantly be discussed in relation to this, but further development of ideas related to this is beyond the scope of this deliverable report.

Meadows outlined a number of places to intervene in systems, from a systems theoretical general perspective. Based on her work, twelve places to intervene in a system were outlined after her death, and we found these point of potential inspiration for the work in ROADMAP, and therefore outlined them in Table 2 in this report with examples from the work done so far in the LLs in ROADMAP.

3.3.2 Social learning and communities of practice

The classical and most quoted literature source on Communities of Practice (CoP) is the first work of Lave and Wenger from 1991 (Lave & Wenger, 1991). Since then, this has been cultivated, shaped into different contexts, disputed and explored in many ways and schools, in relation to situated learning as well as organisational learning, and in relation to formation of identities and meaning. Social learning is in the core of the understanding of CoPs (Blackmore, 2010), and Snyder and Wenger (2004) consider the world as a learning system.

Many different concepts are linked to theories of CoP, and to different degrees and with different weight and angles, for example different concepts of power, change, diversity and formality. All of these are relevant to understanding critical points of action as well as action in different animal farming sectors in ROADMAP, and could be unfolded much more than we intend in this report. However, we need to define and involve the ideas of CoPs, if we want to understand how critical points of action can be formed and articulated and lead to action in different contexts in ROADMAP. The following definition is based primarily on Wenger’s work (Wenger, 1998), and will be followed up by some points for further exploration in the discussion part of this report, which are based on the anthology edited by Blackmore (2010) as well as Cox (2005).

Communities of practice can be understood as sustained mutual relationships, where people develop shared ways of engaging in doing things together, and where they are mutually defining identities, and there is also a mutual understanding of ‘who belongs to this community and why’. With regard to the communication and flow of information, this can be regarded as an ongoing process, often with a rapid flow, and where ‘introduction’ is not needed, and where problems can quickly be set up and mutually understood. The members will often expect to share the same knowledge, and share vocabulary, jargon, styles, discourses, stories,

understandings, conditions that connect them. This can for example be members within one guild or one profession, or linked professions in the same field (e.g. to some extent farmers and ‘people around farming’).

3.3.3 Actionable knowledge and absorptive capacity

Argyris (1996) and Argyris and Schön (1996) conceptualized the so-called ‘theories in action’. It stipulates that people act according to ‘theories’ or carry maps in their head, which they are often not aware of or conscious about. At the same time they articulate other ‘theories’ (espoused one) which are different from their action (theory in use). This is more than a simple gap between what people say and what they do, and according to Anderson (1994; online version) these are two different theories of action. However, if the two theories are congruent, the result is effectiveness. People do measure the consequences of their action strategies. If there is a discrepancy between intended results and observed ones, they may revise either their strategies, action (single loop learning) or even the governing values, either espoused (intentions) or theory in use ones (beliefs and feelings) - this is understood as double loop learning in this context - to obtain strategy effectiveness. Double loop learning is more efficient but may be inhibited. Argyris (1996) describes the values associated to inhibition of double loop learning (Model I - based on defensive strategy) and enhancing double loop learning (Model II - based on informed strategy and testing).

Organisations may foster learning, or not. Creating the condition within the organisation so that people learn, may constitute a third loop based on group learning skills. Two issues were particularly in focus, and addition to communities of practice, which are mentioned above : 1) Knowledge and creating knowledge, 2) Learning itself, at an individual and/or organisational level. Nelson and Winter (2002) focused on iteratively selected **routines** which might help organisations to face and manage change: both individual and collectively by coordinating people, as well as ethically, by enabling people and the organisational structure to cope with high uncertainty.

Cohen and Levinthal (1990) developed and used the concept of **absorptive capacity**, also building on organisational learning. ie ability to take advantage of new information (acquire, assimilate, transform, exploit).

Regarding actionable knowledge, Argyris later carried out a more focused analysis based on epistemology (Argyris, 1996). The key point lied in the links between the theories (generalization), their validity and how to build their validity - mainly based on causality, and the ability (or lack of !) to implement the so-called ‘theories’ in reality. The latter characterized actionable knowledge, and causality links may be of no help in implementation. The debate about respective contribution of researchers or managers to theories and actionable knowledge, theory being conceptualized ex ante, ex post or simultaneously, is not the main point in this context. We found the most interesting point lying in the consistency between theories and concepts on the one hand, and actionable knowledge on the other one, being aligned with management models enhancing learning and implementation (if not subject to innovations themselves) - the discrepancies between the third parts resulting (in the best case) in innovations.

3.4 Definitions of terms used in this report

3.4.1 Levers

The term lever arises from a mechanical world, where it in its most simple form is a rigid piece, which is capable of turning around an axis to transmit and modify force and motion. It is completely connected to the term 'leverage point' in the section above, where the leverage point means the force compounded by this lever. In this context, as in social systems and beyond, it is understood more conceptually as 'the tools' which are able to start moving things to a degree which is far more effectual than what 'the tool itself' can do, and at times to move things which are seemingly 'too big' for the apparent capacity of the lever itself.

3.4.2 Incentives

A motivator or driver to make a person or a group, organisation, company or sector to act or behave in a certain way. Intrinsic incentives motivate a person (or organisation etc.) to do something out of own interest or desires, without any outside pressure or promised reward, for example to learn some skills to become better to communicate with others. Extrinsic incentives are linked with some type of rewards, for example economic rewards, or the opposite: punishments of some kind. Another example of an extrinsic incentive other than economic rewards is grades in the education school system. One of the debated negative consequences of external incentives is that unfortunate competition can arise, or 'dependency' on an incentive among a group of people or organisation so that they stop doing certain things if they are not rewarded.

3.4.3 Real-time indicators

Indicators to monitor development as it occurs, and it is one approach to handle and understand space and/or developments in real-time setting. In ROADMAP, the approach of using video-ethnography is another way of understanding experience in real-time, e.g. working with animals, and has been used in many settings, such as Miaux et al. (2009), where videoing was used to understand subjective experience as pedestrians in urban environments. This should be seen in contrast to historic data from last year or even last week. However, learning from other disciplines using big data sets to intervene in 'real-time' has for example been described in relation to HIV-medical research, where data was used to intervene to prevent HIV-infection (in a setting where GDPR apparently was not an issue; Little et al. 2014). This can be for example measuring certain contents of milk, as the milking goes on, enabling immediate evaluation of the situation, and relevant action. Bus et al. 2020 recommend feeding patterns as a real-time indicator of growing-finishing pig welfare. Van der Sluis et al. (2020) used passive radio frequency indicators as a tracking system to monitor individual broiler activity. Activity was of interest given the relationship between activity and different aspects of health, welfare and performance.

3.5 The ROADMAP initiative to Living Labs to stimulate action

3.5.1 The Living Lab framework in relation to critical points of action

A Living Lab is characterized in literature and previous ROADMAP reviews, as a user-centered, open-innovation research approach, development tool or ecology of practices. They bring multiple stakeholders together and are responsive to their specific territorial context (e.g. city or region). A LL is a ‘lab’ because it combines and integrates processes of co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and technologies. A LL takes place in ‘real life cases’ or ‘real life environments’, involving user communities as a source of creation of something which is useful for them in their context. This approach allows all involved stakeholders to identify the problem, outline relevant strategies, and consider both the overall usefulness of a product, service or strategy, and its potential adoption by a wider range of end-users. This interactional aspect of LLs enables participants to gauge the impact and development of these products (in terms of strategies as well as concrete outputs) throughout its lifecycle, and across different contexts. This makes Living Labs different from many other participatory and action research project where stakeholders and end-users are citizen-oriented.

The process in Living Labs can be modified to the context and be agreed on among participants. However, key points of a LL are the fact that 1) A LL has an initial question / a question which they focus on, 2) A LL is planned and facilitated, and can follow a Learning Loop structure as described in previous ROADMAP reports, 3) It seems that a LL is operational and relatively easy to overview for all when it is of a size at about 10-20 participants, 4) A LL in ROADMAP will meet at least 4 times during WP3 and WP4, but to work through a learning loop or cycle, preferably more, 5) The process in a LL is documented and there is a reflection process at the end of each LL.

During the establishment of the Living Labs in ROADMAP, we realized that a LL can operate at all levels, either in parallel, to address a cross-cutting issue related to AMR and fostering transitions towards prudent AMU, or in consecutive steps. This means that innovations and implementations can be of the following types:

- e) Technical – either focused on promoting health or preventing / handling disease in a certain sector,
- f) Social at more levels from farm to society and in organisations: how do we articulate responsibility between several groups of actors? How is it articulated in relation to for example our thinking of ‘responsibility’?
- g) Institutional and structural level: who pushes the development and use of antibiotics? How is legislation supporting the phasing out of antibiotics?
- h) Any of the above in combinations.

3.5.2 Necessary considerations related to Living Labs to initiate action

Three main aspects will be briefly considered in this section, as they are identified as potential challenges or points of necessary considerations, during the establishment and collection of first experiences of Living Labs in ROADMAP:

- d) Is there a good match between the problem addressed, the level at which it is addressed, the critical points of action, and the combination and range of stakeholders?
- e) How to transform ‘conflicts of interest’ to ‘commonality of interest’ within the Living Lab?
- f) Does the Living Lab have a chance to actually act and influence or stimulate change – do they have what we called ‘space of operations’?

Regarding **point a)**, in relation to identifying critical points of action, as well as initiating and planning the potential actions themselves, the Living Lab needs to consider at least the following two aspects:

A1) The level(s), at which the chosen problem area exist in the given context. The LL will identify critical points of action (physical, technical, psychological, social, and institutional motivations, incentives, stimulators, levers or structures), and identify, plan and stimulate the action in ways which enables initiating and driving substantial and lasting change, including actions directed towards overcoming barriers and lock-ins which hindered action.

A2) The range and combination of stakeholders to address the problems, which the LL sets out to address; the ‘optimal mix of stakeholders’, fitting to the diverse contexts within the project, and to some extent also that the persons representing the stakeholders are able to take the role in the Living Lab.

It is paramount for the Living Lab to consider these two aspects to ‘test’ whether there is a promising match between the identified problem including common consciousness about at which level this problem should be addressed, and the selected potential actions to overcome this problem.

Regarding **point b)**, a number of potential or experienced key conflicts of interests among stakeholders are identified. This is a very important issue where the LL-coordinators can help each other to develop ways in which this can be dealt with. The role of the facilitator is very important to be aware of, and it might be necessary to use different methods, such as individual interviews, involvement of new stakeholders or help from outside ‘experts’. If transition at a larger scale should happen, it is necessary to reach a commonality of interests in the Living Lab.

Regarding **point c)**, situations have been described among the Living Labs, where there are literally no possibilities to approach the problem. For example in cases of integrated industries, it can be very difficult to work in an area, where basically not choices can be taken because it is all given in the industry (e.g. some poultry sectors). A similar issue could potentially arise in cases, where goals, problems or actions are pre-determined e.g. by project partners, which leave the Living Lab the option of being ‘test-beds’ for new innovations.

In relation to this discussion, it might be interesting to consider the range of widely different time frames in which LLs are foreseen to work. Coenen and Robijt (2017) describe for example a framework for what they call ‘Agile Living Labs’, which builds on LLs both from inductive and deductive approaches in a business setting, with the aim of making the LL ‘actionable’ and

‘quickly reacting’. They work with phases quite similar to the ones, we have worked with in ROADMAP (problem formulation and BIEL (Build-Intervene-Evaluate-Learn) and formalizing of learning, the latter of which basically is to bring the learning outside the LL). They work with different roles suited for an innovation-purpose: process manager, user researcher, researcher, architect, UX Designer, developer, user, and stakeholder. This is very much about testing and seeing enduser perspectives to innovations, which could be developed by or in close collaboration with industries, and seem close to original LL-developments. The needs for this type of approach is also described in ROADMAP, e.g. testing of different benchmarking methods, ear tags or technologies. At the other end of the scale, Gamache and co-authors (2020) work with Living Labs in relation to profound local agri-food sustainability transitions. They follow the European Network of Living Lab definitions, with a multi-actor approach, and visions of multi-faceted systemic transitions, involving notions of addressing ‘the commons’ and addressing territorial issues and emphasizing the importance of this in fostering alternatives to a dominant food system approach.

4 Case descriptions from ROADMAP

The advantage of a systemic perspective [...] is the appreciation that actions are invariably also interactions. Thus what any one individual might actively do in the world, can, and frequently does have an influence on other humans as well as on the ‘rest of nature’, directly or indirectly. And this has ethical implications.
(Richard Bawden, 2000; quoted by Blackmore, 2010)

Twelve Living Labs have been described and established to various degree in ROADMAP. The following sections are based on examples from the case studies in ROADMAP, and from the Living Labs, where six had experience from the first one or two gatherings, and six was under establishment and planning, and where the stakeholders are engaged.

4.1 Examples of levers and incentives for change

Incentives to reduced AMU are debated at all the levels in which the ROADMAP case studies and Living Labs work. In example 4.1.1, the lack of direct payment for AMU reduction may cause that farmers lose money or cannot afford to implement measures which can help reduced AMU. There is a huge amount of examples of pressures or incentives, e.g. case study

Example 4.1.1. Incentives to AMU reductions in the Swiss case study on organic pig farming: there are no possibilities for direct payment to farmers for reduced AMU reached by better animal health and welfare. Swiss farmers normally optimize their income with all kinds of direct payments. However, there are currently, no options for general direct payments to farms with a low use of antimicrobials or improved animal health.

There are possibilities for increased income with more attractive market or political instruments, e.g. an increased animal welfare, although the payments do not cover the costs of the measure. Farmers implement the measures also based on their ethical values.

leaders from the UK mentioned in previous interviews supermarket-led schemes and benchmarking of farms as two AMU reducing strategies, which could give advantages for the farmers, or punishment and exclusion if they do not follow the scheme. In some cases, they are followed up by advisory service, community of practice formation of some kind, guidance, or other initiatives, which can be attractive.

Incentives to reduced AMU can also be given or directed via legislation, or political decisions at regional or national levels or beyond, e.g. the case study on the poultry sector in the Italian case study in Example 4.5.3 (below). In example 4.1.2, there is an urge from government and authorities to reduce AMU, which in itself could be regarded as a strong incentive, given the foreseen consequences of not meeting this urge. At the same time, even the farms are not directly part of an integrated industry, they are locked by the fact that services, inputs and abattoirs are in Germany, so beyond their control.

Example 4.1.2. The Dutch case of turkey production: facing a situation of being urged to reduce AMU and at the same time having no decision power.

- The Dutch turkey sector has been urged by the governmental system to reduce AMU over the past few years, and programs have been established to help this. The ROADMAP LL was one of the initiatives to meet this requirement.
- The sector is under pressure and has no decision power. Despite the fact that the producers are not necessarily part of an integrated industry as such, all inputs (chicken, feed, production guidelines etc.) comes from German companies, and the turkeys are slaughtered in Germany.

Many different levers are mentioned in the examples below, both in terms of access to technical and social resources, e.g. improvement of training and involvement of young farmers, health and welfare improvements, or investment in healthy piglets is another lever to change AMU, so no treatment is needed at the fattening farm.

Example 4.1.3. Levers and incentives for change the Swiss case study on organic beef/veal calf farming

- There are actors that do not want a change of the existing system. Among them, dairy farmers afraid of having more work, fatteners, animal traders afraid of losing their business model
 - Political and market incentives/direct payments/increased market price dairy farmers to keep calves longer on their farm.
 - Make traders part of the solution.
 - Better prices for meat. There is a good price for young calves for fattening. The number of cows is decreasing and so the connected number of calves too. But the number of fatteners did not change. Hence, there is a high demand for calves to run their business economically.
- Raise the awareness across the entire sector that change is still needed. The sector has acted and according to their (common and current) understanding, no more action is needed.

4.2 An example of testing of real time indicators

In *the Swiss pig case study*, the testing of a new digital earmark measuring temperature or feed intake has the potential to inform farmers in real-time about the individual health status of pigs. This would allow individual treatments instead of group treatments. The earmark measuring feed intake will be tested during ROADMAP. The earmark measuring temperature is still under development.

4.3 Critical points of action at the level of the farm including supportive structures in the farming sector

Most case studies and Living Labs include elements of on-farm initiatives, because this is where AMU takes place, as result of or response to many other influences from the whole sector. Much emphasis is put on training, monitoring and development and/or testing of different tools such as some of the work in the two Swiss LLs in example 4.3.1.

Example 4.3.1. from the Swiss case study on organic beef/veal calf farming and the Swiss case study on organic pig farming. Training of farmers about calf health / pig health among others through exchange and visits. Currently farmers are not trained in calf health management. Vets will also be trained – many vets do not know much about organic farming. In Switzerland there is now a whole program on calf health management, in which the Swiss LL will work with adjusting this system specifically to organic conditions.

As the example in 4.3.2 from Mozambique shows, is there a major effort on development of best practices, involving all levels of the sectors, where the example 4.3.3 focuses on the use and development of different approaches to farmer groups and ‘coaching’ of different farm related professionals.

Example 4.3.2. In Mozambique multiple stakeholders and experts participate in regular meetings aimed at the co-construction of best practices guidelines. Participants at these meetings include representatives of the Ministry of Agriculture, the Association of Mozambican veterinarians, the pharmaceutical industry, the Poultry Farmers Association of Maputo, and the Consumer Association of Mozambique.

Example 4.3.3. The Danish LL on dairy cow and calves aims at develop practice tools for veterinarians and advisors to enhance the dialogues on-farm. Both well-known methods as the Stable School approach, which has been used for 15 years, will be used and tested in organic and non-organic farms, but also a focus on improved dialogue and knowledge exchange with migrant workers on farms, material for farmer students, and group learning in relation to calf farming, as well as different (other) approaches to group involvement of farmers will be used as part of the LL development.

In Belgium, two LLs will determine and follow the testing of technical (and possibly also social) innovations, which will be tested by a group of farmers contracted by the research partners in a so-called Action Lab, which has a kind of test-bed design.

Example 4.3.4. The two Belgian Living Labs on pig and veal calf farming, multistakeholder LLs will develop and choose innovations to test on volunteer farms contracted by the ROADMAP partners, in so-called Action Labs.

4.4 Critical points of action at industry/sector level

Many critical points of action can be described at industry level, which have many possibilities of creating incentives and pressures.

One of the major challenges identified and mentioned by more ROADMAP partners is the integrated industries, which have full power over farmers / producers, and in some cases control all inputs, services and sales possibilities of a sector.

Example 4.4.1. The Italian poultry LL is faced with the challenge – and opportunity – of an integrated industry, which controls all technical interventions and conditions. This means that the Italian LL on poultry production probably will focus on sociological / social aspects within the sector.

Another challenge – and opportunity – is when the industry offers certain conditions to certain producer groups, like the example 4.4.2 from the Danish case study on pig farming, where a limited number of farmers are offered a premium for reducing AMU.

Example 4.4.2 An example of a critical point of action on the industry level in the Danish case study on pig farming. Danish Crown, the largest pig processing company in Denmark, offers (a restricted number of) farmers the opportunity to participate in a concept called “OUA” (‘Pure Pork’; raised without antibiotics) where they are given a higher prize for pigs, that they can guarantee have never been treated with AB in their lifetime after birth. The farmers producing within this framework are at times gathered by Danish Crown, and the veterinary consultancy group ‘Svinenet’ works in many of these herds and facilitate ‘experience exchange groups’ (in Danish called ‘erfa-grupper’).

However, one potential challenge of niche production can be that it is excluding broader sector from meeting a goal. In this case, the goal is AMU reduction, which in some ways can be seen as having a societal interest. Getting closer to reaching a goal of societal interest will in such case relies on consumers paying more for the products. However, learnings from such initiatives can also in some cases be seen as learnings from ‘first-movers’/‘innovators’, which

transferred to other farmers, showing examples to a sector or society, which can learn that ‘it is possible’, and ‘how can it be possible’.

Example 4.4.3 An example of a critical point of action on the industry level in the Swiss case study on organic pig farming

- One slaughterhouse and retailer are driving forces to increase the transparency of AMU in the organic sector. In collaboration with animal traders, they plan to test and implement a digital earmark that will collect information about treatments.
- There is price pressure on the meat market. By communicating the added value of good meat (healthy animals, good animal welfare), consumers might be willing to pay more.

They will accompany the initiatives with tools to prevent diseases and / or measure animal welfare.

Critical points of action at sector levels have been discussed in some cases, where there is a disconnection within ‘the sector’. This is typical in the dairy farming sector throughout Europe, where calves are sold out of the dairy farm in a young age, to go to a calf farm, as the example 4.4.4 outlines. The example is from Switzerland, but similar situations exist in UK, Denmark, Belgium and France. This can be examples of ‘critical points of action’ belonging at the sector level, but reaching out to call for structural changes at farm level (such as making space for more calves, so that they can stay on the dairy farm), or the legislation level, as example 4.5.2 shows.

Example 4.4.4 of a critical point of action on the industry level in the Swiss beef and veal calf farming

Keeping the calves longer than 21 days on the dairy farms. The sector agreed, that calves are only allowed to be traded within the first 21 days of their lives.

- Support the collaboration between dairy producers and veal/beef producers, and stimulate joint action of all actors. A recent interview study revealed that actors from abattoirs felt that they were supposed to solve problems created in the dairy industry, where ‘over-supply of calves’ was a problem (Rell et al., 2020)
- This may also lead to structural changes at farm level, there is often not enough space to keep calves longer than 21 days.
- This may also be part of a public debate, because few citizens are aware of these structures.

4.5 Critical points of action at legislator level

Many examples across countries point to the importance of legislation and regulation to higher or lower AMU, to active efforts to bring it in focus, and to support initiatives to it. One of the cases, which will be described in ROADMAP, is the decade long process in Sweden, where governments and sectors set goals to minimize AMR risk, and bring the AMU to a minimum. At the same time, there was an emphasis that sick animals should be treated, and the only allowed treatment methods and medicines are those, which have undergone natural scientific approved controlled trials.

Example 4.5.1 from Sweden, where the Case Study describes learnings and story lines from 20+ years of governmental legislation, critical points of action was a public and societal wish to farm animals with minimum AMU, and hence through legislation to support, create incentives and action to reduce the use of antimicrobials in Sweden

The Swedish case study reveals how a whole governmental program over the years can lead to a generally reduced level of AMU in the agricultural sector. This is in-depth described in other deliverables coming out from ROADMAP.

It seems that ROADMAP comprises two main approaches to address the level of legislation:

1) to influence the implementation of legislation, or the legislation itself, e.g. by discussing how the legislation should be formulated or practiced, and where the critical point of action is realizing that some legislation is contradictory or contra-productive to the goal of reducing AMU. Example 4.5.2 could be an example of this.

Example 4.5.2. In the Danish Living Lab on dairy cattle, stakeholders identified an issue that some structures regarding subsidies and tax systems contradict an aim of reducing AMU in calves: antibiotic treatments are relatively cheap, and keeping male calves are subsidized for at least a two-year period. This combination leads to farmers being tempted to keep a high number of calves in space, originally built for fewer, or with a high influx, outflux and mixing of animals from different herds. This lead to higher levels of disease, hence more antibiotic treatments. The Danish Living Lab will raise this problem and create awareness at the regulatory level that this creates dilemmas, in terms of animal welfare and high AMU.

2) to help the practical implementation of actual legislation or governmental plan in a certain sector or region. In this case, the critical point of action can be said to be the legislation, and the actions will be on sector level, to facilitate or help solving challenges in implementing the legislation. The examples in box 4.5.3, 4.5.4 and 4.5.5 could be an example of this.

Example 4.5.3. Italy has instituted a national plan to reduce AMU, which the Italian LL on pigs builds on. In 2018, the region of Emilia-Romagna set up a permanent expert working group involving all the relevant stakeholders of the livestock industry to discuss and support the implementation of the evolving legislation on AMR and veterinary AMU. This was done to give ideas about AMR for new rural development plan; the administration is particularly interested in this (quantify the use of antibiotics etc.). The work involving multiple stakeholders could be help working on documenting and measure / quantify the use of AMU in this context.

Example 4.5.4. Critical points of action for the French LL on pig and poultry is based on the French Ministry's interest in developing a monitoring tool for AMU

The French LL on pig and poultry works on different levels, and the monitoring tool focusing on how to monitor antibiotics and health/disease is fulfilling and communicating with the Ministry's urge to and interest in this development. The LL will (among others) deal with issues of confidential information, which might be shared in ways which most farmers normally are resistant to, but the LL approach involving multiple stakeholders may develop solutions to this.

Example 4.5.5. The Dutch case study on pig farming and turkey farming.

In the pig sector, case study leaders mention the research project ABRES-vet-med and the ABRES research program, which was commissioned by the Ministry of Agriculture, Nature and Food quality (EL&I). ABRES includes a working group/network as well as two projects aimed at coaching entrepreneurs in the pig sector. In the Netherlands there are working groups/networks on reducing AMU in turkey and pig production. WAAK, the working group on AMU reduction in turkey production involves veterinarians and feed suppliers.

4.6 Critical points of action at society level

Even though the original intention of this report was to focus on farm, industry, sector and regulatory levels, many of the critical points of action reach out on societal level, where a better understanding among citizens and organisations of life and priorities, dominances and power structures in the farming and food systems could be urgent and necessary to foster changes.

Several Living Labs mention contributions to public debates as one of the focus areas. This debate both can take place within communities of practice / colleague groups (e.g. in farmer magazines, veterinary journals etc.), as well as in media such as newspapers, blogs, and radio or TV programs.

As can be seen from example 4.6.1, the UK LL focuses on improved involvement of calf care people, who are often marginalized, and calf care is often viewed as less prestigious among all types of professionals in the sector. This means that the LL and Case Study aims at giving voice to the marginalized people and animals, and through the increased awareness on these issues, also contribute to a changed view on aspects of farming at a wider society level, which may change views and lead to joint action and mutual understandings.

Example 4.6.1. of a focus in the UK CS on addressing issues of marginal care and marginal voices. The focus is on high AMU, but there are structures in the way in which calves are kept, that both put them and their caregivers in high risk of poor welfare, and AMU. Some research methods to show and share life worlds will be used in the process, and the LL will take a certain shape and may start with only calf caregivers. Technical innovations could also be relevant, but will come second. Although the CS and LL are focused on farm levels, they also bring the outputs to a stakeholder stage of the living lab, and in addition, the relevance of addressing this at societal level is hugely relevant to foster change in attitudes.

4.7 Summing up on integrative strategies to foster change across levels

As seen from the above, many issues may refer to integrative strategies, using and combining widely different tools in multi-stakeholder settings, taking the advantage of combining capacities, resources and perspectives, and moving across the levels of business, sector, governance and multiple stakeholder, to address complex and multi-faceted goals, as e.g. described by the Integrative Strategies Forum (see <https://www.isforum.org/what-are-integrative-strategies>).

5 Discussion on critical points of action across the levels of farm, industry, regulatory and society levels

Based on experiences from the initial stages of twelve Living Labs with the overall goal to work for a more prudent AMU, we will discuss the issues raised at the different levels involved in the actions and interactions, that is, farm, industry, regulatory and to the possible extent also societal levels.

As one of our discussion models we suggest Donella Meadows' systems thinking about places to intervene in a system, because we can see animal farming and the use of antimicrobial in the animal farming sector, as a system (with several subsystems, and being part of larger systems, as is always the case when defining a system).

We see LLs as leverage points in the system, 'instruments for creating change and intervene in the system'. That means that we see LLs in ROADMAP having potentials to foster change of AMU, and we will discuss and suggest conditions for this to happen, and explore whether LLs themselves can be characterised as learning organisations.

5.1 From critical points of change

5.1.1 Learning from previous work on critical points of change

MS19 consisted of a list of critical points for change at farm, industry (agricultural sector including organisations, and food supply chains), and regulatory levels. The M19-report was

based on the following understanding of critical points of change: *“physical, technical, psychological, social, institutional and organizational instruments, actions, interactions, structures and other factors which can change AMU at different levels, by stimulating actors and stakeholders, overcoming barriers or loosening lock-ins. In our work we include three levels: 1) regulatory / governance level, 2) industry (food and agriculture related industries), and 3) farm and agriculture local level, and we understand actors as closely related to stakeholders, and use these two terms intertwiningly”*. A number of points arose from the list, some of which are summarized below:

- Policy is a relevant driver of change in AMU. However, the impact of the EU widely harmonized policy is very heterogeneous across Europe, and high awareness among all actors is needed, as well a pressure to act and improve the AMU.
- Besides several similarities, the structures in the animal farming sector vary hugely from country to country and case study to case study; the need to address different areas follows this. Prominent differences were for example:
 - Strong weight on monitoring AMU and/or conducting self-inspection as part of some LLs, where others lived in countries with close monitoring of AMU and/or self inspection as a part of the legislation in the veterinary field during the last decades,
 - Differences in how independent vet advisors were and whether a country had tradition to have veterinarians as advisors. E.g. where some partners saw a need to increase uniformization of advice, others stated the opposite: advise needed to become more context dependent,
 - Incentives, whatever the way (higher market prices for labelled products or funding aimed at prudent use), were also widely mentioned. However, there are differences in whether consumers were seen as relevant drivers of change in a ROADMAP context, or it was rather governance elements, or it was more relevant to focus on the change within the agricultural sectors,
 - The potential role of (independent) research varied; it was generally regarded as necessary, especially concerning focused network and system/practice oriented and interdisciplinary research, but emphasized to different degrees.
 - Mindsets of the actors are important. Some partners experienced, that new perspectives on the AMU are difficult to communicate and new measures to decrease AMU are hard to be implemented. This is based on previous experiences but also based on “outdated” knowledge of the actors. Forstering awareness, training and education, was plebicated, whatever the levels (vet, farmers, industry) and means (education, training, coaching, exchange groups) The sectors are widely different between ROADMAP partners: there is huge difference between e.g. small sectors (like the Dutch turkey sector) and large integrated industries (such as the Italian poultry sector). Some LL mentioned forstering alternative and/or improved animal welfare oriented production systems as food for thought.

- Critical points for change are closely related to this heterogeneity, and it is obvious that we need flexible approaches to strategies to reduce AMU and to meet the sector-related, personal, structural and institutional needs.
- Some of the listed points of change belong at more than one level, e.g. training, education or inspection systems can be initiated and organized at all levels.

5.1.2 Critical moments of change

In WP2, the ROADMAP partners are looking at 'critical moments of change', which is the points in time in which major changes have happened in the past. We then analyse what was happening at those points in time that led to change, using participatory and qualitative research methods.

5.2 Which places to intervene in ROADMAP?

In this section, we suggest to view animal farming through systems thinking lenses, and we understand leverage points as places to intervene in these systems, where relatively small changes can lead to proportionally much bigger changes. In this light, we found it relevant to explore how the wide range of initiatives in ROADMAP can be analysed and how we can suggest these initiatives to be organised in a common framework of systems under change. We outlined and introduced the ideas of systems thinking by Meadows and colleagues in section 3.3.1. In Table 2 we explore very briefly and suggest the twelve places to intervene in a system in relation to the ROADMAP focus points for the work in the LLs and case studies, followed by a short discussion. We need to underline that the work of Meadows and her colleagues – who took over and presented and discussed some of her work after her death – also is broad by nature, and that Meadows and other authors themselves urged the readers to be cautious, as Meadows wrote: *'So much has to be said to qualify this list. It is tentative and its order is slithery. Every item has exceptions that can move it up or down the order of leverage. [...] The higher the leverage point, the more the system will resist changing it – ...'* The Living Labs in ROADMAP are still at a very initial stage, and much has to come to enable a more profound analysis. However, we attempt to suggest different frames of understanding and analysing the initiatives, the cases and the ways in which different LLs as well as larger structures in the CSs structure themselves, to be able to learn and respond relevantly throughout the project, as is expected in participatory action research.

Table 2. The critical points of action and the actions in ROADMAP organised in relation to the unfolding of places to intervene in a system through relevant leverage points, according to Meadows (2008; edited by Wright).

Places to intervene in the system in increasing order of effectiveness according to Meadows (2008)	Suggestions as to how ROADMAP Case Studies and Living Labs include these leverage points / potentially intervene, based on described experience until February 2021.
12. Numbers – constants and parameters such as subsidies, taxes, standards	Presence or lack of price incentives for reduced AMU or punishment schemes for increased/high AMU described in CSs, and mentioned in some LLs.
11. Buffers – the sizes of stabilizing stocks relative to their flows	Imbalances described in some CSs, where systems are stabilised as a high AMU-level, hence difficult to intervene. Descriptions of high levels of integration in some sectors, or global markets. May be difficult to follow, influence and document within the time frame of ROADMAP, but can possibly be analysed using historic data. The awareness in the processes of participatory action research can potentially contribute to describe beginning trends and tendencies.
10. Stock-and-flow-structures – physical systems and their nodes of intersection	
9. Delays – the length of time relative to the rates of system changes	
8. Balancing feedback loops – the strength of the feedbacks relative to the impacts they are trying to correct	
7. Reinforcing feedback loops – the strength of the gain of driving loops	
6. Information flows – the structure of who does and does not have access to information	This is a main focus area in many CSs, WPs and LLs in ROADMAP: working with info access, and production of info and documentation, as a means or leverage point of change. An increased focus on actionable knowledge may also involve this leverage point.
5. Rules – incentives, punishments, constraints	LLs can be seen as strong tools to some extent, to address this level, in the first instance on local / national levels and when being part of enabling environments.
4. Self-organisation – the power to add, change or evolve system structure	Depending on the systems boundaries and what is understood as ‘the system’ in each case, this is challenged and needs to address and involve e.g. integrated industries, globalised markets and structures which are identified as very challenging in individual sectors or national contexts.
3. Goals – the purpose or function of the system	
2. Paradigms – the mindset out of which the system – its goals, structure, rules, delays, parameters - arises	
1. Transcending paradigms	Could be a potential contribution of the collected ROADMAP project.

5.3 From critical points of action to action and interaction

As outlined above, communities of practice is in many contexts understood as sustained mutual relationships between humans, in some cases living in a local community (e.g. a farming community), and often in a professional setting (gilt, profession and/or educational background). In a CoP, the ‘members’ share mutual understandings of ‘who belongs to this community and why’, as well as same types and sources of knowledge, vocabulary, jargon, styles, dis-courses, stories, understandings, and conditions. This can for example be members within one gilt or one profession, or linked professions in the same field (e.g. to some extent farmers and ‘people around farming’). In an organisational setting, the CoP also refers to a relatively

informal, intra-organizational group, which in some way or another is facilitated by management to for example learn or create something together. Some has also referred to such groups as ‘constellations of practice’ (e.g. Wenger et al., 2002), and some have discussed the level of ‘interconnectedness’ in such groups. Cox (2005) emphasises that there is increasing recognition that organizations can be seen as ‘communities of communities’, containing many different types, not just communities of practice. Cox (2005) also opens up for perspectives on how - in such cases - the latent power of indirect social relations can be channelled into organizational purposes and become quite dynamic and for example form new norms, practices and / or understandings, if facilitated right, and being in an enabling environment. In the ROADMAP context, these perspectives can be of importance for Living Labs, which can be seen as groups formed across different CoPs, maybe with the potential to form new CoPs in new organisational structures, maybe recognised ‘Communities of Action’. To be effective as such, the enabling environment must be present, and there must be a good match between stakeholders, goals of the LLs and the level of action exist.

6 Conclusion and future perspectives

Based on the initial experiences and consideration, we conclude that a Living Lab can operate at different levels regarding critical points of action, either in parallel, to address a cross-cutting issue related to AMR and fostering transitions towards prudent AMU, or in consecutive steps. This means that innovations and implementations can be of the following types:

- a) Technical – e.g. promoting health or preventing / handling disease in a certain sector),
- b) Social at more levels from farm to society and in organisations.
- c) Institutional and structural level: who pushes the development and use of antibiotics?
- d) Any of the above in combinations, and initiatives targeting or involving societal levels broadly.

The following questions are paramount to address during the establishment and first evaluation of the mode and space of operation in ROADMAP-LLs:

- a) Is there a ‘good match’ between the problem addressed, the level at which it is addressed, the critical points of action, and the combination and range of stakeholders?
- b) How to transform ‘conflicts of interest’ to ‘commonality of interest’ within the Living Lab?
- c) Does the Living Lab have the necessary ‘space of operations’?

Living Labs can be viewed as formed across different CoPs, potentially with the potential to form new CoPs in new organisational structures, recognised ‘Communities of Action’, if the enabling environment is present, and the above mentioned ‘good match’. In this case, they may foster change through a transition from conflict of interest to commonality of interest. Furthermore, the potential to identify context relevant places to intervene in a system, provides an interesting framework which can be unfolded much more when the body of experience builds up within and between the different LL contexts.

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